The Stratigraphic Palynology of the Macquarie River Valley, Central Western New South Wales

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The palynology of samples from bores in the Macquarie River Valley has provided evidence of the age of the sediments. The Neogene-Quaternary valley fill is underlain by Mesozoic sedimentary rocks and possibly older units. Upstream of Narromine, the basement is Triassic, and downstream, it is Jurassic-Cretaceous. Late Miocene-Pliocene assemblages are found over the whole region, and there are a few occurrences of early and mid Miocene assemblages. Most of the Neogene assemblages occur at relatively shallow depths, but west-southwest of Narromine, they are found at greater depths of about 100 m, suggesting that this is the region of the palaeovalley of the Macquarie River. Identification of the important aquifer, the Pilliga Sandstone, should be based on evidence of lithology, hydrology etc., in addition to palynological age, for extensive units such as this are not necessarily the same age over the whole of their extent.

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INTRODUCTION

The allocation of water resources between competing interests in the semi-arid regions of western New South Wales is at times controversial. Groundwater is an important component of the resource, and knowledge of the geology is necessary for proper management. The Tertiary alluvial fill of the river valley is a source of groundwater, but it may overly a basement of older sediments that may be virtually indistinguishable on lithologies alone. The Macquarie River Valley in central western New South Wales extends across the southern edge of the Middle to Late Jurassic Pilliga Sandstone, a well known aquifer. Palynology is essential for the identification of these different units. This paper reports the stratigraphic palynology of bores in the Macquarie River Valley (Fig. 1).

MATERIALS AND METHODS

Samples of sediment from bores (Figs 1, 2) were supplied by the Department of Land and Water Conservation. The samples are first soaked in water, then treated with hydrochloric acid to remove all carbonates, if present. They are then treated with hydrofluoric acid to remove silicates. These two acids together remove all mineral matter. If sand and/or gravel are present, they are removed by decanting early in the treatment. Processing times and concentrations vary, depending on the nature of the sample.

The organic residues are oxidised with Schultz solution (nitric acid saturated with potassium perchlorate) to dissolve degraded organic matter. Treatment with an alkaline solution, sodium carbonate, then removes the dark coloration, making the residues suitable for examination under the microscope. Again, times and concentrations vary,

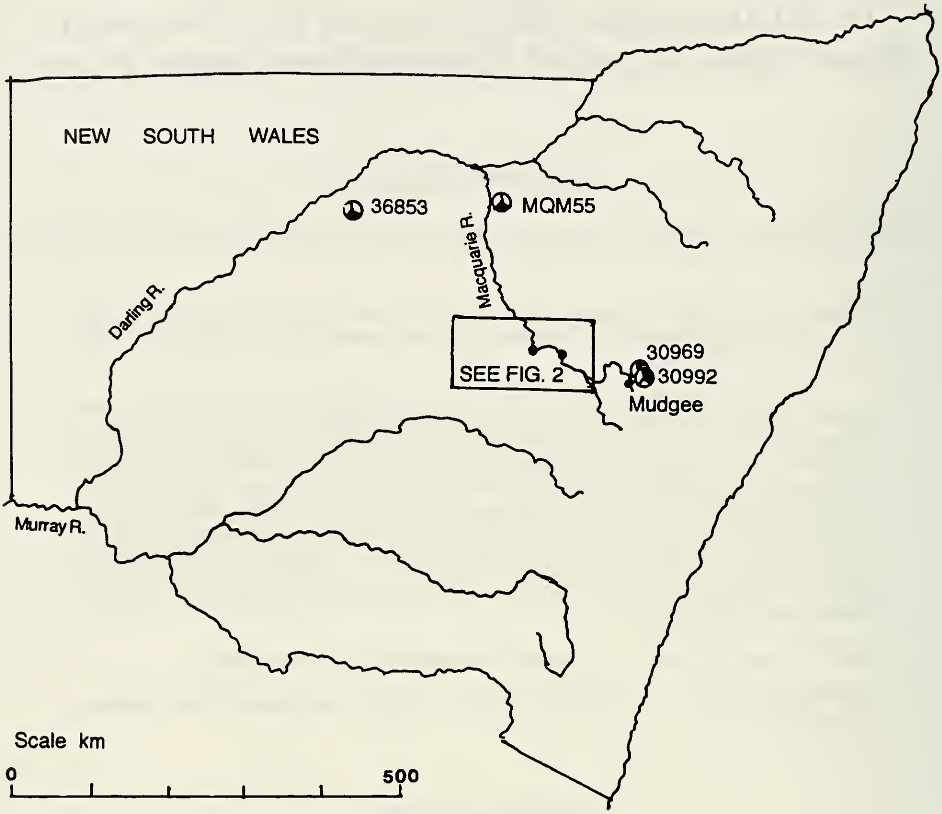

Figure 1. Locality map. For legend to bore symbols, see Fig. 2.

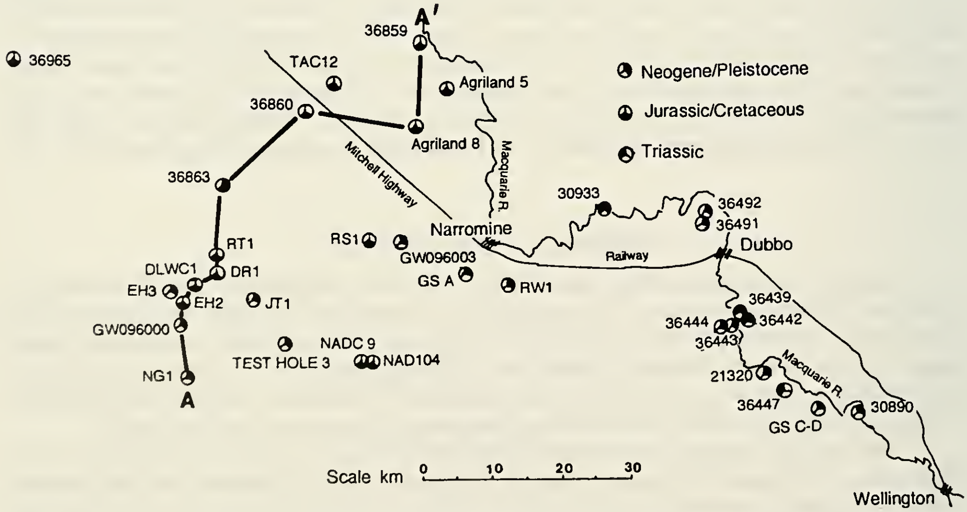

Figure 2. The area of detailed study. For a more precise age of the bores, see Table 1 in the Appendix.

depending on the nature of the sample, and the final treatment with an alkali may be omitted on highly oxidised samples. The residues are then mounted on a microscope slide in glycerine jelly.

The pollen and spore assemblages are matched with descriptions in the literature of palynological zones which have been dated. The most recent zonations are used here (Figs 3, 4, 5). Some older, unpublished reports may be based on older zonations, but they have been updated to the most recent ones used here. The change makes no difference to the age, or a very slight difference if the ranges of diagnostic species have been modified.

Good assemblages with some diagnostic species may be assigned to a zone, but if diagnostic species are not present, then the general abundance of some species may indicate a superzone. With very poor assemblages, even a superzone may not be possible, but as there are hardly any species common to the Mesozoic and the Tertiary, then even a few grains will distinguish these two ages.

GEOLOGY

A complex sequence of Paleozoic rock units underly this region (Sherwin 1996). Mesozoic sediments of the Coonamble Lobe of the Surat Basin, part of the Great Australian Basin, overly the Paleozoic sequence. Narromine and Dubbo are close to the southern limits of widespread Mesozoic sediments, although small remnants of Mesozoic sediments may be found further south near Trundle (Hawke et al. 1975) and Molong (Gibson and Chan 1999). The Middle Jurassic Purlawaugh Formation, the Middle-Late Jurassic Pilliga Sandstone and possibly the Late Jurassic-Early Cretaceous Keelindi Beds are found in this area. Upstream from Dubbo, there is some Triassic of the Gunnedah Basin (Raymond et al. 1997). Cainozoic sediments fill the valley and may form a thin veneer elsewhere (Raymond et al. 1997; Sherwin 1996).

STRATIGRAPHIC PALYNOLOGY

A summary of the results for each bore is given in Table 1 of the Appendix. Many more samples and bores have been examined, but they proved barren, and are not included here.

Triassic assemblages

Triassic palynomorphs are very poorly preserved, with only a few of the most robust forms identifiable. The species identified in selected assemblages are presented in Appendix Table 2. *Falcisporites australis* is common and this places it in the Triassic *Falcisporites* Superzone (Helby et al. 1987). *Aratrisporites* spp. are present, indicating a mid Triassic age, possibly the *A. parvispinosus* Zone, or even the *A. tenuispinosus* Zone (Fig. 3). These data show that the basement upstream from Dubbo, where intersected, is Triassic, and there is one occurrence of a Triassic assemblage between Dubbo and Narromine (Fig. 2).

Late Jurrassic to Early Cretaceous assemblages

The species identified in selected assemblages are presented in Appendix Table 3. Following Helby et al. (1987), the Jurassic *Callialasporites dampieri* Superzone (Fig. 4) is recognised by an abundance of *Callialasporites* spp. *Microcachryidites antarcticus* first appears in the mid Jurassic, but it is not common. An abundance of *M. antarcticus* is characteristic of the overlying *Microcachryidites* Superzone which begins at the base of the Tithonian in the Late Jurassic, and continues into the Early Cretaceous (Helby et al.

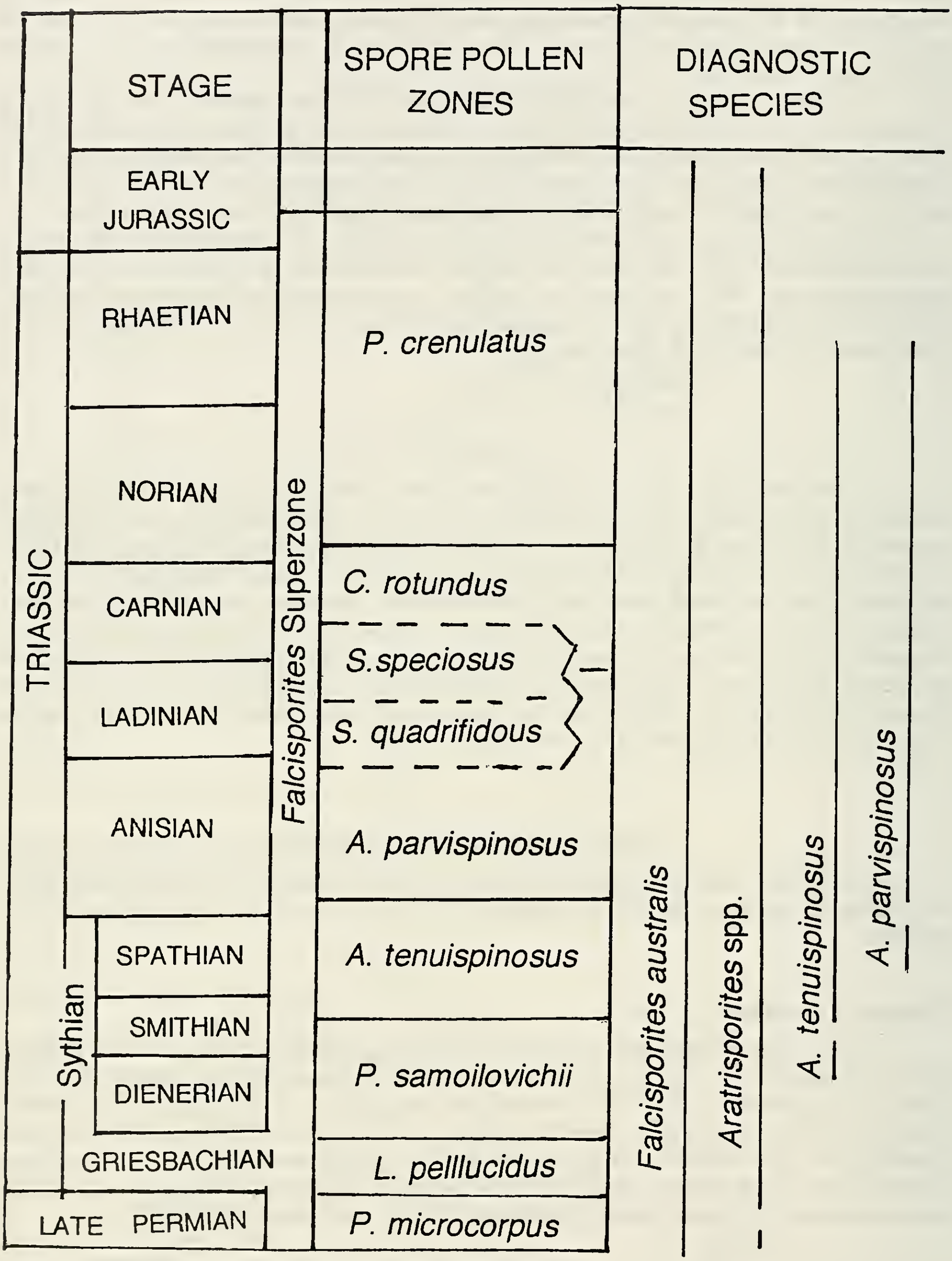

Figure 3. Range chart for Triassic species. From Helby et al. (1987).

1987). If diagnostic species (Fig. 4) are present, then the assemblage may be placed in a Zone. The sediments range in age from the Mid-Late Jurassic *Murospora florida* Zone to the earliest Cretaceous *Cicatricosisporites australiensis* Zone. All of these assemblages were deposited in non-marine environments. Late Jurassic to Early Cretaceous sediments are found north, west and southwest of Narromine (Fig. 2)

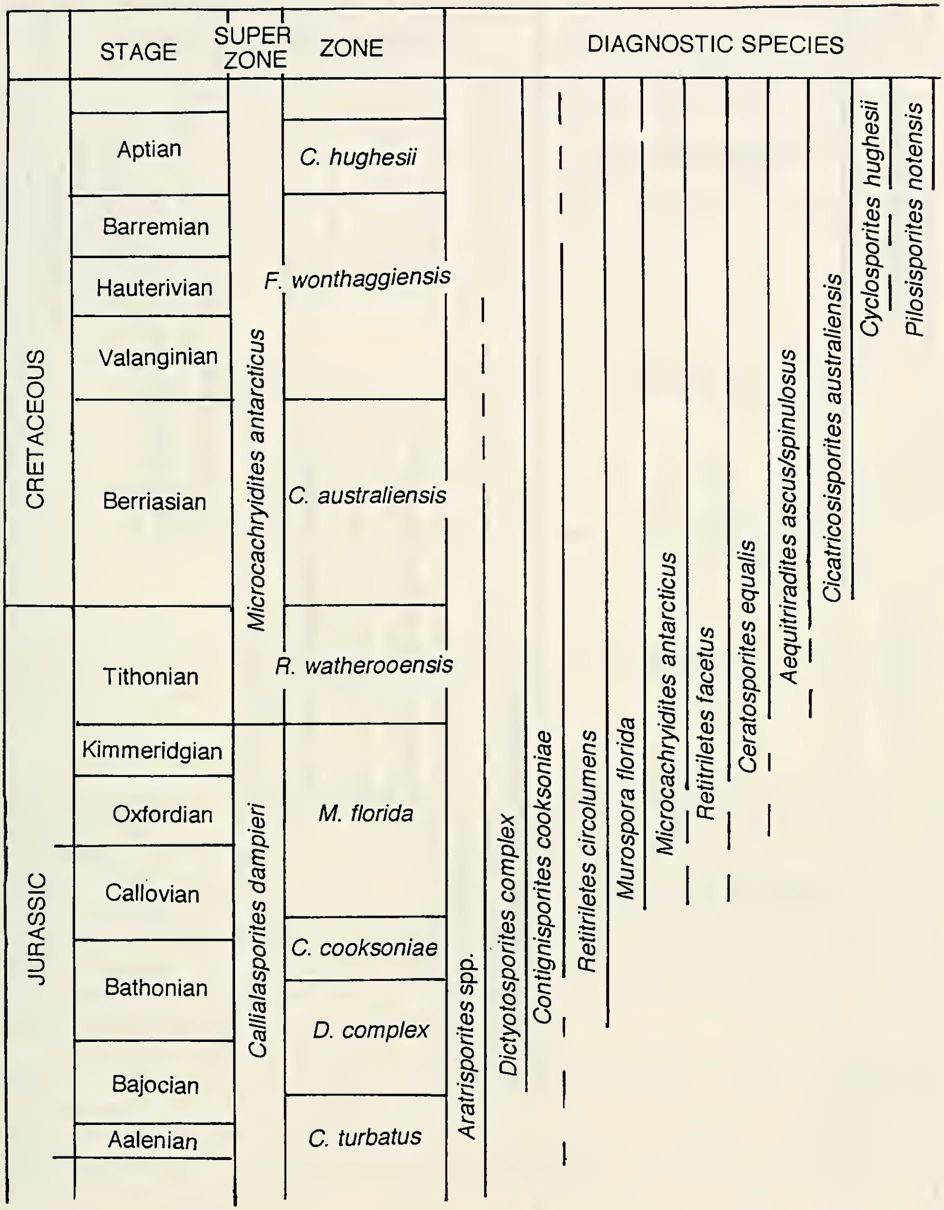

Figure 4. Range chart for the Mid-Late Jurassic and Early Cretaceous. From Helby et al. (1987).

North of the area of intensive investigation, sediments of the earliest Cretaceous *C. australiensis* Zone occur in the Macquarie Marshes region, and deposits of the Aptian *Cyclosporites hughesii* Zone is found near Bourke (Fig. 1). Both assemblages contain dinoflagellates and acritachs (Table 2), which indicate marginal marine environments of deposition.

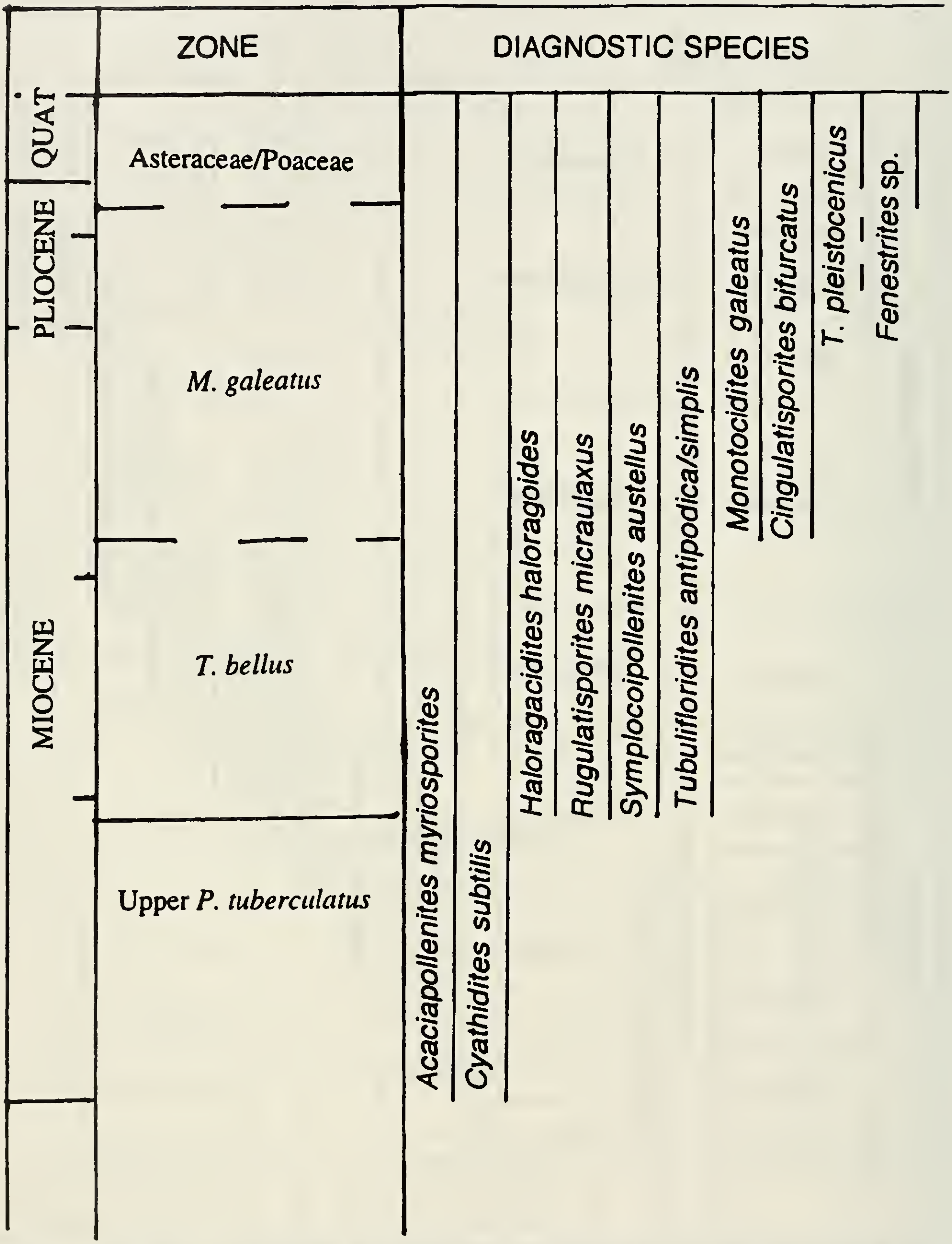

Figure 5. Range chart for the Neogene and Pleistocene. From Macphail and Truswell (1993), Martin (1987) and Stover and Partridge (1973).

Tertiary and Pleistocene assemblages

The species identified in selected assemblages are presented in Appendix Table 4. The early Miocene Upper *Proteacidites tuberculatus* Zone (Stover and Partridge 1973) is marked by the first appearance of *Acaciapollenites myriospora* (Fig. 5), and is found

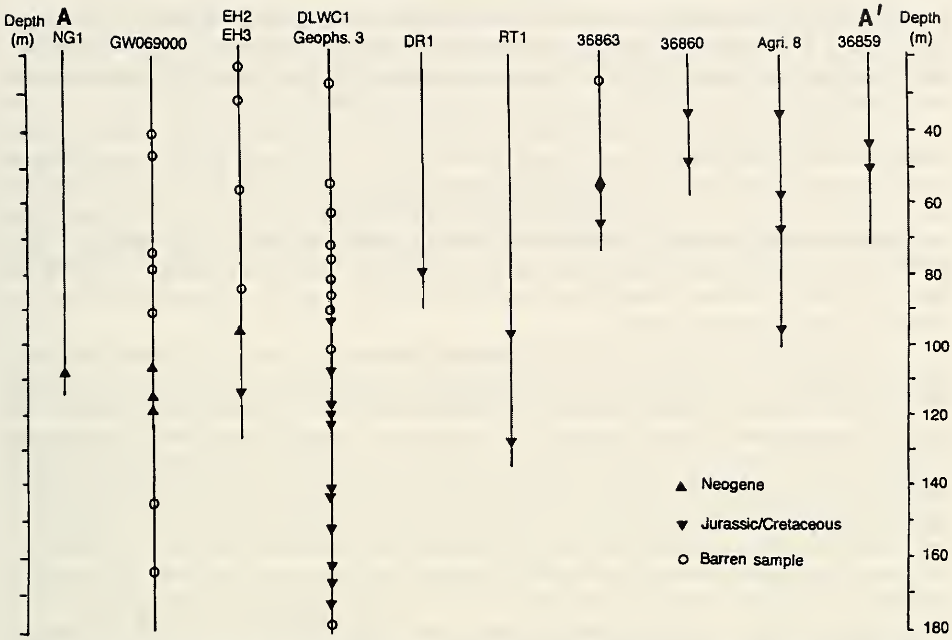

Figure 6. Cross section west of Narromine. For the location of bores, see Fig. 2. For the palynological zones and a more precise age of each bore, see Table 1.

west of Narromine. *Haloragacidites haloragoides*, *Rugulatisporites micraulaxus* and *Tubulifloridites antipodica* denote the Mid-late Miocene *Canthiumidites* (=*Triporopollenites*) *bellus* Zone (Stover and Partridge 1973), which occurs near Narromine. The probable assemblage of the *C. bellus* Zone near Mudgee has an appreciable *Nothofagidites* spp. content, which is more typical of older assemblages, but which may be found occasionally throughout the Neogene. *Monotocidites galeatus* and *Cingulatisporites bifurcatus* indicate the late Miocene-Pliocene *Monotocidites galeatus* Zone (Macphail and Truswell 1993), which may be found west of Narromine, but it is most common upstream of Dubbo (Fig. 2).

Tubulifloridites pleistocenicus (Asteraceae) and *Fenestrites* sp. (Tribe Cichoreae of the Asteraceae) mark the top of the *M. galeatus* Zone, and the Pleistocene Asteraceae/Poaceae assemblage (Fig. 5). Other Asteraceae (*Tubulifloridites antipodica/simplis*) and Poaceae (*Graminidites monoporites*) are usually abundant also. Other characteristics of Pleistocene assemblages include a very reduced spore and gymnosperm content and an overall reduction of species diversity.

DISCUSSION

The stratigraphic palynology and ages reported here rely on diagnostic species which are not common, and, if the assemblage is not very diverse, may be based on only one key species. For example, 9 samples between 120 m and 175 m in bore DLWC1 yielded assemblages which are generally similar, and have been assigned to the *Murospora florida* Zone. However, only two of the diagnostic species, *M. florida* and *Retitriletes facetus* which demarcate the base of the *M. florida* Zone, are found, and then only in 3 of the samples. The other six samples lack diagnostic species of the zone. When there is a sequence from the one bore in which the assemblages and sediments are all similar, as in bore DLWC1, then it is reasonable to assume they all belong to the same zone.

With single samples from a bore, difficulties may arise. For example, bores NADC9 and NAD104 are close to each other (Fig. 2), and very similar assemblages were recovered from the 104–126 m level in the former, and the 94–97 m level in the latter. A single grain of *Cicatricosisporites australiensis* in the 104–126 m level places the assemblage in the younger *C. australiensis* Zone, whereas the lack of this species in the 94–97 m level places that assemblage in the older *M. florida* Zone (Table 1, Fig. 4). In this case, other evidence should be considered, along with the palynological age, to arrive at a satisfactory outcome.

The identification of the Pilliga Sandstone is critical, because of its importance as a regional aquifer. The Pilliga Sandstone is generally regarded as Late Jurassic (Hind and Helby 1969; Sherwin 1996), based on palynological evidence from bores more than 200 km to the northeast. The palynology of a sandstone at Spring Ridge, which has all the lithologic and hydrologic characters of the Pilliga Sandstone and was mapped as Pilliga Sandstone, was however found to be Early Cretaceous (Martin 1981) *Foraminisporis wonthaggiensis* Zone (Fig. 4), based on the most recent zonations used here. Experience has shown that formations which may be identified on grounds of lithology, hydrology, etc., over large areas, are not necessarily the same palynological age over the whole of the area, i.e. are time transgressive, and this applies particularly to the margins of the unit. Spring Ridge is near the eastern edge of the Pilliga Sandstone, and Narromine is near the southern edge. Other evidence, as well as palynology, should be taken into account to identify the Pilliga Sandstone.

The same problem of scarcity of diagnostic species applies to the Neogene assemblages. There is an overall trend of loss of rainforest taxa, and a lower diversity of species throughout the Neogene, but this trend is extremely variable geographically. For example, the *C. bellus* assemblage at Mudgee has an appreciable content of the rainforest taxa *Nothofagidites* spp. (Table 4), whereas at Narromine it is minimal. This difference may be attributed to a geographic difference in the source vegetation. In New South Wales, increasingly dry climates through the Neogene (Martin 1998) forced a retreat of rainforest taxa from the drier, western regions first, restricting them eventually to the eastern highlands. Assemblages with appreciable *Nothofagidites* spp. are found at Lake George in the Highlands, in the latest Pliocene, just below Asteraceae-Poaceae assemblages (McEwen Mason 1989), but a high content of *Nothofagidites* spp. is more typical of Palaeogene assemblages in the western regions of New South Wales. Some of the assemblages have a high content of *Araucariacites australis*, representing araucarians such as hoop pine, bunya pine, kauri, which are now found in the drier rainforest habitats. The variability in the palynology reflects the patchiness of the vegetation.

An increase of Asteraceae, the daisy family (collectively *Tubulifloridites antipodica/simplis*, *T. pleistocenicus* and *Fenestrites* sp.), and Poaceae, grasses (*Graminidites media*) is a palynostratigraphic marker horizon that can be recognised over much of New South Wales. Accompanying this change, is a reduction of the spore content (chiefly ferns) and also in the gymnosperm pollen, most of which represents rainforest species (Table 4). This change, which represents the opening up of the forests and the development of grasslands and herbfields/shrublands, has been palaeomagnetically dated as 2.5–2.9 million years at Lake George (McEwen Mason 1989, 1991). It is assumed the same ecological trend occurred at about the same time elsewhere.

Fig 6 shows a cross-section west of Narromine. The southern end of the transect shows Tertiary assemblages occurring at depths of more than 100 m, whereas at the northern end, the Jurassic/Cretaceous basement may occur at depths as shallow as 40 m.

This suggests that the old Tertiary palaeovalley of the Macquarie River probably continued in a westerly direction after Narromine, instead of turning north, as it does today. The depth to pre-Tertiary bedrock contour map, based on hundreds of bores drilled in the area west of Narromine (S. Haridharan, pers. comm.) supports this conclusion.

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APPENDIX

TABLE 1.

Summary of results. Bores arranged approximately W to E, then N to S (see Figs 1, 2).

Bore	Depth (m)	Results of Palynology	Age
		North of the detailed area (Fig. 1)	
36853	147.3	*C. hughesii* Zone	Early Cretaceous (Aptian)
MQM 55	79–80	*C. australiensis* Zone	Early Cretaceous (Berriasian)
		West of Narromine	
36965	110–132	A few long ranging Mesozoic spp.	Mesozoic
36859	43–51	*C. australiensis* Zone	Early Cretaceous (Berriasian)
TAC12	80–82	Uppermost *Callialasporites*/ lowermost *Microchacryidites* Superzones	Late Jurassic
Agriland 5	60–88	*R. watherooensis* Zone	Late Jurassic (Tithonian)
36860	35–49	*C. australiensis* Zone	Early Cretaceous (Berriasian)
Agriland 8	34–98	*R. watherooensis* Zone	Late Jurassic (Tithonian)
36863	56–57	Tertiary with minor reworked Cretaceous spp.	Tertiary
	65–66	*C. australiensis* Zone	Early Cretaceous (Berriasian)
RS1	95	A few long ranging Mesozoic spp.	Mesozoic
GW069003	88.5	*C. bellus* Zone	Mid–late Miocene
RT1	97–129	A few Mesozoic types	Mesozoic
DR1	78	Uppermost *Callialasporites* / lowermost *Microchacryidites* Superzones	Late Jurassic
GS-A	88–89	*C. bellus* Zone	Mid–late Miocene
DLWC1 (Geophysical site 3)	93–175	Upper *M. florida* Zone	Late Jurassic
EH3	96–97	A few long ranging Tertiary spp.	Tertiary
EH2	114	A few long ranging Mesozoic spp.	Mesozoic
JT1	73	A few upper Tertiary spp.	Miocene–Pliocene
GW096000	107–119	Upper *P. tuberculatus* Zone	Early Miocene
NG1	109	*M. galeatus* Zone	Late Miocene–Pliocene
Test hole 3	91–92	*C. bellus* Zone	Mid–late Miocene
NADC9	104–126	*C. australiensis* Zone	Earliest Cretaceous
NAD104	94–97	Upper *M. florida* Zone	Late Jurassic
GS A	88–89	*C. bellus* Zone	Mid–late Pliocene
		Narromine–Dubbo	
RW1	50	*M. galeatus* Zone	Late Miocene–Pliocene
30933	49–55	*M. galeatus* Zone	Late Miocene–Pliocene
	61.5–66.5	*M. galeatus* Zone, a few Permian/Triassic grains	Late Miocene–Pliocene
	70–72	*Falcisporites* Superzone, ?*Aratrisporites parvispinosus* Zone	Mid Triassic
36492	21.5–22	*M. galeatus* Zone	Pliocene
36491	42–43.5	*M. galeatus* Zone	Late Miocene–Pliocene
		Dubbo–Wellington	
36439	12–13	Asteraceae-Poaceae	Pleistocene
	38–40	*Falcisporites* Superzone, ?*Aratrisporites parvispinosus* Zone	Mid Triassic
	40	*M. galeatus* Zone, rare reworked Permian/Triassic grains	Late Miocene–Pliocene
36442	24–30	*M. galeatus* Zone	Late Miocene–Pliocene

	36–38	*Falcisporites* Superzone, ?*Aratrisporites parvispinosus* Zone	Mid Triassic
39443	36–37	*M. galeatus* Zone, rare reworked Permian/Triassic grains	Late Miocene–Pliocene
36444	18–19	*M. galeatus* Zone	Late Miocene–Pliocene
21320	30.8–35.7	*M. galeatus* Zone	Late Miocene–Pliocene
39447	67–68.5	*Falcisporites* Superzone, ?*Aratrisporites parvispinosus* Zone	Mid Triassic
GS C-D		*M. galeatus* Zone	Late Miocene–Pliocene
30890	19–20	*M. galeatus* Zone	Late Miocene–Pliocene
		Mudgee (Cudgegong River)	
30969	17.1–23.2	*C. bellus* Zone	Mid–late Miocene
30992	5.5–6	Asteraceae/Poaceae with reworked Permian/Triassic grains	Pleistocene

TABLE 2.

Triassic assemblages. Taxonomy follows Helby (1973) and Helby et al. (1987).

Species	Bore Depth (m)	36442 36–38	36447 67–68.5	36439 38–40
Alisporites parvus		+		
Alisporites spp.		+	+	+
Apiculatisporites sp.		+	+	
Aratrisporites banksii		+		
A. parvispinosus		+	+	
A. tenuispinosus		+		
Aratrisporites spp.		+		+
Baculatisporites comaumensis			+	
Cyadopidites follicularis		+		+
Cyathidites australis				+
C. minor			+	
Falcisporites australis		+	+	+
Guthoerlisporites cancellosus		+		+
Neoraistrickia taylori		+	+	
Neveisisporites limulatus				+
Osmundacidites sp.		+		+
Platysaccus queenslandii		+		
Polypodiisporites ipsviciensis		+		
Protohaploxypinus sp.		+		
Striomonosaccites sp.				+
Vitriesporites signatus			+	

TABLE 3.

Selected Jurassic/Cretaceous assemblages. Identifications of spores and pollen follow Balme (1957), Dettmann (1963) and Helby et al. (1987). Identifications of dinoflagellates follow Morgan (1980) and Lentin and Williams (1989). +, present. ++, common. Zones: 1. *Murospora florida.* 2. *Retitriletes watherooensis.* 3. *Cicatricosisporites australiensis.* 4. *Cyclosporites hughesii*

	Bore	DLWC1/ Geophys. 3		Agri. 5	Agri. 8	36859	36860 55	MQM	36853
	Depth (m)	143.3	164.3	87–88	96–97	43–44	48–49	70–80	147
Species	**Zone**	1	1	2	2	3	3	3	4
Aequitriradites acusus/spinulosus				+	+	+			
Alisporites grandis						+			+
A, similis						+			+
Alisporites spp.		++	++	+	+				
Aratrisporites spp.			+						
Araucariacites australis			++	+	+	+		+	++
Baculatisporites comaumensis			+	++	++	++	+	+	++
Biretispoires spectabilis						+	+		
Callialasporites dampieri		+	+		+				
C. segmentalis			+	+		+			
Ceratosporites equalis				+		+	+		+
Cicatricosisporites australiensis							+	+	
C. hughesii				+			+		
C. ludbrookii				+			+		
Cingulatisporites clavus								+	
Contignisporites cooksonii							+		
Coronatisporites perforata							+		
Cooksonites variabilis					+				
Corallina (=*Classopollis*) sp.			+			+		+	+
Couperisporites tabulatus				+					
Crybelosporites stylosus									+
Cyathidites australis		+	+	++	+	+	++	+	+
C. minor		+	+	+		+		+	+
C. punctatus						+	+		
Cyclosporites hughesii									+
Dictyotosporites complex				+	+	+			+
D. speciosus									+
Foraminisporites dailyi				+		+			+
Foveotriletes parviretus									
Gleicheneiidites spp.		+	+					+	+
Ginkgocycadophytus nitidus				+	+	+			
Inaperturopollenites sp.									
Ischyosporites cf. I. marburgensis					+				

I. punctatus					+			+
Klukisporites scaberis	+	+	+		+		+	
Krauselisporites linearis								+
Leptolepidites verrucatus			+		+			
Lycopodiacidites asperatus		+			+	+		+
Microchacryidites antarcticus	+	+	+		+	+	+	++
Murospora florida	+	+	+			+		
Neoraistrikia truncatus	+	+	+	+		+	+	+
Osmundacites wellmanii	+	+	+	+	+			+
Pilosisporites notensis								+
P. parvispinosus							+	
Polycingulatisporites sp.								+
Podocarpidites spp.	+	++	++	++	+	+	++	++
Reticuloidosporites arcus								+
Retitriletes austroclavatidites	+	+		+	+	+	+	+
R. circolumens	+	+	+	+	+		+	+
R. facetus	+	+	+				+	
R. nodosa	+		+		+			+
Retitriletes spp.			++	+	+		+	
Schizosporits reticulatus					+	+		
Sestrosporites pseudoalveolatus	+	+						
Stereisporites antiquasporites							+	
Todisporites minor		+						
Triletes cf *T. tuberculiformis*		+			+			+
Trilobosporites purverulentus					+			
Triporoletes sp.						+		
Dinoflagellates and acritachs								
Adanatosphaeridium sp.								+
Cleistosphaeridium ancoriferum							+	
Cyclonophelium densibarbartum							+	
Cyclonophelium sp.							+	
Hestertonia cf. *H.striata*							+	
Kiokansium polypes								+
Micrhystridium sp.							+	+
Nummus monoculus							+	+
Oligoshaeridium complex								+
O. pulcherrinum								++
Spiniferites sp.								+
Stephanodium sp.							+	
Tenua hysterix							+	++

TABLE 4.

Selected Tertiary assemblages. Identifications follow Martin (1973), Stover and Partridge (1973) and Macphail and Truswell (1993). Where percentages from counts of about 150 grains are not available, + = present, or present but not in the count, and ++ = common. Zones: 1. Upper *Proteacidites tuberculatus*, early Miocene. 2. *Canthiumidites bellus*, late early-late Miocene. 3. *Monotocidites galeatus*, late Miocene–Pliocene. 4. Asteraceae/Poaceae, Pleistocene.

Bore	GW096000	30969	GS A	NG1	36444	31320	36439	30992
Depth (m)	107.5	17–23	88–89	109	18–19	33–36	12–13	5.5–6
Zone	1	2	2	3	3	3	4	4
Spores								
Baculatisporites disconformis					0.7			
Cingulatisporites bifurcatus					0.7	2.3	3.2	0.9
Cyatheacidites annulatus	+		+					
Cyathidites paleospora	+	3.7	++	+	5.6	3.1		
C. subtilis		0.7						
Deltoidospora inconspicua		1.5			0.7	5.5	0.8	0.9
Gleicheniidites circinidites	+	0.7		+	2.2	1.6		
Klukisporites lachlanensis		0.7						
Laevigatosporites ovatus	+	11.0	+		2.2	1.6		
Matonisporites ornamentalis	+				1.4			
Polypodiidites sp.		0.7						
Reticuloidospora minispora						2.3		
Rouseisporites sp.								1.8
Rugulatisporites mallatus				+				
R. trophus	+		+					
Stereisporites sp.					0.7			
Gymnosperms								
Araucariacites australis	++	2.2	+	++	36.2	3.1		
Cupressaceae		1.5				0.8		0.9
Dacrycarpus australiensis	+	2.2	+	+	2.9	7.8		
Lygistepollenites florinii	+	0.7		+		0.8		
Phyllocladidites palaeogenicus						0.8		
Podocarpidites spp.	+	3.7	+	+	6.5	14.8		
Angiosperms								
Acaciapollenites myriosporites	+				0.7			
Chenopodipollis chenopoodiaceoides							0.8	5.3
Cunoniaceae/Elaeocarpaceae		2.2						
Cupanieidites orthoteichus		2.2						
Cyperaceaepollis sp.			+			1.6	1.6	5.3
Dodonaea sphaerica					0.7			
Ericipites crassiexinus	+				0.7			
Fenestrites sp.							0.8	
Glencopollis ornatus			+				0.8	0.9
Graminidites media					1.4		6.4	12.5
Guettardidites sp.				+				
Gyrostemonaceae				+				
Hakea sp.					0.7			

Haloragacidites haloragoides	++			+	0.7	2.3	0.8	
H. harrisii		15.4	++	++	21.7	8.6	9.6	1.8
H. myriophylloides				+	0.7			3.6
Liliacidites sp.				+				
Micrantheum spinyspora			+	+				
Milfordia hypolaeniodes					1.4			
Monotocidites galeatus				+		0.8		0.9
Myrtaceidites eucalyptoides		7.3	+			2.3	6.4	11.6
Myrtaceidites spp.	+	11.1	+	+	5.0	19.5	62.4	20.5
Nothofagidites asperus		1.5				3.1		
N. emarcidus	+	14.6	+	+				
N. flemingii		0.7		+				
Proteacidites spp.		1.5						
Psuedowintra tetradites	+		+			2.3		
Quintinia psilatispora		1.5						
Stephanoclopites oblatus			+	++				
Symplocoipollenites austellus			+		1.4			
Tricolporopollenites endobalteus			+					
Tubulifloridites antipodica/simplis				+	1.4		2.4	20.5
T. pleistocenicus								7.1
Unidentified angiosperms		12.5		+	2.9	10.9	4.0	3.6
Microplankton								
Botyocuccus braunii			+					
Debarya sp.		+	+	+				
Zygnema sp.				+				
Reworked Permian forms								
Didecitrilets ericanus			+					
Dulhuntyispora parvitholus			+					+
Protohaploxypinus sp.			+					+
Striatoabies multistriatus			+					